June 1994

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by Fred Samson and Fritz Knopf

> The prairie appears almost monotonous in the general uniformity of its plant cover. Its main features are the absence of trees, the scarcity of shrubs, the dominance of grasses, and a characteristic xeric flora.
>
> —Weaver 1968, p. 48

The health and future of the earth's ecological systems (Dailey and Ehrlich 1992), their link to the well being of communities and nations (Raven 1990), and the ever-increasing rate of loss of species, communities, and ecological systems (Myers 1993) are among issues drawing biological diversity into the mainstream of conservation worldwide. Yet, in North America, there is no single, established priority in the conservation of biological diversity. In recent years, a great deal of attention has been paid to the problem of tropical and temperate deforestation in part because of profound consequences to the conservation of biological diversity (Harris 1984, Whitmore and Sayer 1992.). Despite a broad consensus supporting the conservation of biological diversity (CEQ 1991), native prairie is largely neglected in this effort. This article suggests why native prairie in North America should be among the priorities in conservation of biological diversity. We further describe the extent and cause of the decline of North American prairie and offer recommendations for prairie conservation.

Why is prairie conservation important? Consider, for example:

- The largest vegetative province in North America is the native prairie, and grasses as an integral component of prairies inhabit the continent in greater abundance than any comparable group of plants. Surveys suggest that since European settlement declines in area of native prairie range as high as 99.9%. More subtle impacts in the loss of prairie, for example, loss of the highly developed ecotypic differentiation, often go undetected (Risser 1988). In addition to direct loss, exploitation by overgrazing and recreation adds to the stress on remnant prairie (WWFC 1988). And, once the prairie is destroyed, restoration requires several centuries (Schramm 1990).

- Humanity's present position of domination and economic well being are affected by grasses, because they provide directly or indirectly the majority of human nourishment. Today agricultural erosion in North America exceeds the prairie soil's capacity to tolerate loss, threatening an essential resource to sustain future generations (Sampson 1981). The impounding and alteration of running waters, the depletion of aquifers, and the increase in waterborne chemical pollutants also threaten prairies and their soils (TCF 1988).

- The potential for species extinction on grassland is of serious concern. Fifty-five grassland species in the United States are threatened or endangered, and 728 are candidates. One-third of species considered endangered by the Committee on the Endangered Wildlife in Canada are found on grasslands (WWFC 1988). Grassland bird species have shown more consistent and steeper, geographically widespread declines (25–65% declines from 1980 to 1989) than any other grouping of North American species (Knopf 1992). Several species, including the Eskimo curlew and Audubon bighorn sheep, and subspecies, including the plains wolf and plains grizzly bear, no longer exist.

- The health of planet Earth, in the face of global warming, may depend on prairie grasslands because they are superior carbon sinks in comparison to forests with similar environmental characteristics (Seastedt and Knapp 1993). Large amounts of stored carbon in grassland soils reflect fundamental differences between grasses and trees.

Where the buffalo roamed

The area of native prairie that once extended from Canada to the Mexican border and from the foothills of the Rocky Mountains to western Indiana and Wisconsin is referred to as the Great Plains. The main bodies of prairie within the Great Plains are: the tallgrass prairie extending from Canada and Minnesota south to Texas, the mixed grass prairie from Canada and eastern North Dakota south to Texas, and the shortgrass plains reaching from western Texas and New Mexico north to eastern Montana.

Approximately 162 million ha of prairie blanketed the Great Plains before European agriculture. As early as 1830, homesteading in Indiana and Illinois began to alter forever the extent of the grasslands (Table 1). Since 1830, the declines (estimated to be 82–99%) in area of tallgrass prairie exceed those reported for any other major ecosystem in North America including remnant old-growth forest in the Pacific northwest, temperate rainforest in British Columbia and southeast Alaska, and bottomland hardwoods in the south-central United States.

Estimated declines in native mixed-grass prairie area, although less than the tallgrass declines, range from 30% in Texas to 99% in Man-

Table 1. Summary of the estimated current area, historic area, and percent decline of the tallgrass, mixed grass, and shortgrass prairies. The estimates of current and historic prairie area are based on information from The Nature Conservancy's Heritage Program; USDI Fish and Wildlife Service; USDA Forest Service; Canadian Wildlife Service; Provinces of Alberta, Manitoba, and Saskatchewan; and state conservation agencies. N/A indicates data not available. No area estimates of historic and current mixed-grass prairie are available for Colorado, Kansas, Montana, Oklahoma, Wyoming, and of shortgrass prairie for Colorado, Kansas, Montana, Nebraska, Oklahoma, and New Mexico.

	Historic (ha)	Current (ha)	Decline (%)	Current protected (%)
Tallgrass				
Manitoba	600,000	300	99.9	N/A
Illinois	8,900,000	930	99.9	<.01
Indiana	2,800,000	404	99.9	<.01
Iowa	12,500,000	12,140	99.9	<.01
Kansas	6,900,000	1,200,000	82.6	N/A
Minnesota	7,300,000	30,350	99.6	<1.0
Missouri	5,700,000	30,350	99.5	<1.0
Nebraska	6,100,000	123,000	98.0	<1.0
North Dakota	1,200,000	1200	99.9	N/A
Oklahoma	5,200,000	N/A	N/A	N/A
South Dakota	3,000,000	449,000	85.0	N/A
Texas	7,200,000	720,000	90.0	N/A
Wisconsin	971,000	4000	99.9	N/A
Mixed grass				
Alberta	8,700,000	3,400,000	61.0	<.01
Manitoba	600,000	300	99.9	<.01
Saskatchewan	13,400,000	2,500,000	81,3	<.01
Nebraska	7,700,000	1,900,000	77.1	N/A
North Dakota	13,900,000	3,900,000	71.9	N/A
Oklahoma	2,500,000	N/A	N/A	N/A
South Dakota	1,600,000	N/A	N/A	N/A
Texas	14,100,000	9,800,000	30.0	N/A
Shortgrass				
Saskatchewan	5,900,000	840,000	85.8	N/A
Oklahoma	1,300,000	N/A	N/A	N/A
South Dakota	179,000	N/A	N/A	N/A
Texas	7,800,000	1,600,000	80.0	N/A
Wyoming	3,000,000	2,400,000	20.0	N/A

itoba. As evident in both the tallgrass and mixed-grass prairie, the shortgrass prairie has decreased in area (ranging from an estimated 20% decline in Wyoming to 85% in Saskatchewan). Only the shortgrass prairie, largely located on the National Grasslands managed by the USDA Forest Service, remains today in public ownership.

A striking feature of prairie is the array of native herbivores, part of a large amount of native biological diversity (Risser 1988). The historic estimate of 60 million plains bison, once the most significant herbivore, may have declined in the great slaughters of 1870–1873 and 1880–1883. An alternate explanation for the bison decline is disease brought northward by domestic cattle as early as the 1860s (Koucky 1983).

The decline in prairie-dog numbers, the second most significant herbivore on the Great Plains, is estimated to be 98% since European settlement (Marsh 1984). This decline has been attributed to potential competition between prairie dogs and cattle for grass forage, a claim neither supported by data (O'Meilia et al. 1982) nor by the suggestion that ungulates and prairie dogs are symbiotic foragers (Krueger 1986). A variety of species, including the black-footed ferret, swift fox, ferruginous hawk, and mountain plover, that are closely associated with the prairie dog are endangered, listed as a candidate threatened or endangered species, or experiencing significant declines. Less obvious are ecological changes that result from the prairie dog's decreased role in nutrient cycling and soil formation.

Of the 435 bird species breeding in the United States, 330 have been documented to breed on the Great Plains. Declines from 1969 to 1991 in grassland birds vary: 24–91% in Illinois, Minnesota, Wyoming, Nebraska, and Missouri; and 17–48% in Colorado, the Dakotas, Kansas, New Mexico, and Texas. The declines in grassland bird species are largely a problem in North America, more of these birds breed and overwinter north of Central America (Knopf 1994).

These declines reflect two conditions. The first condition is loss of grassland habitats for breeding and wintering—for example, the Sprague's pipit, declining in numbers annually at a rate of 3.3%. Second, fire control and woody plantings on the Great Plains have favored increases in numbers of forest-edge birds historically only present in midwestern oak and eastern deciduous forests (Knopf 1986). The loss of six subspecies due to hybridization as a consequence of these forested stepping stones and artificial corridors rivals the loss of three species attributed to forest fragmentation in the eastern deciduous forest. These recent, non-historic forest patches and woody corridors bordering rivers on the Great Plains favor movements of reptiles and mammals from east to west, thus adding to the degradation of the historic biological diversity of the Great Plains (Knopf and Scott 1990).

Economics over ecology

Environmental problems are often evidence of how markets fail to maximize the well being of a society (Dailey and Ehrlich 1992). Since the 1870s, economics and farm policy have led to the agricultural development of the Great Plains (Barnes 1993). The result has been to increase the cultivation of marginal lands and chronic overproduction of foodstuffs.

A primary example in the United States is the deep economic depression and ecological collapse of the 1930s. During the 1920s, the genesis of a farm credit program, excess capability to produce and regular agricultural surpluses, heightened

foreign competition, and the problem of what were considered to be low prices led to the depression (Schultz 1945). The response by the Roosevelt administration was one of economics—to provide jobs and to educate farmers about practices that could reduce soil erosion (Cochrane and Ryan 1976). The goal, to create new economic opportunity even on marginal lands, was based in part on the belief that if new technology was adapted to the Great Plains, the American dream of a decent income could be achieved.

In unrestricted markets, environmental and economic problems arise when individuals and markets fail to account fully for the consequences of their decisions (Costanza and Daly 1992). Few in the 1930s recognized the ecological sensitivity and nature of the Great Plains ecosystems and realized that native grasses held the prairie soils together (Weaver 1968). Without native grasses, wind erosion evident in the dust bowl and black blizzards of the 1930s carried away topsoil, and farmers lost their farms.

From 1938 to 1941, the Civilian Conservation Corps sought to control wind erosion by planting trees, which had not previously been present in historical times. The USDA Soil Conservation Service, given the responsibility to rehabilitate the rangelands, seeded with an exotic, crested wheat grass imported from Siberia. It is a serious environmental threat today. Even the purchase by the Soil Conservation Service of approximately 11.3 million acres of marginal lands was not intended to create a permanent natural area of prairie, but rather to restore those lands for the remaining human residents (West 1990).

The connection of overproduction and economic dislocation was recognized by John Steinbeck when he wrote the "tractor does two things—it turns the land and turns us off the land" (1917, p. 43). From 1870 to 1910, free land was offered to anyone interested in cultivating a small parcel of native grassland. However, the comparison of number of homesteads to the growth in number of farms from 1870 to 1910 suggests that less than one-fifth of the new farms were homesteads (Shannon 1945). Since the 1920s and 1930s, the combination of a system of farm support, a reliance of domestic and foreign markets, abundant credit, and technology—machinery to chemicals—has resulted in a constantly declining farm population on the Great Plains. The Omnibus Farm Acts of 1985 and 1990 continue to encourage farmers to farm more intensively. Nearly 60% of the Great Plains area lost rural, small-town populations in the last decade, and we expect the outmigration and economic decline to continue.

The long-term solution to prairie conservation may revolve around a single emerging concept—sustainability (IUCN 1980, IUCN/UNEP/WWFN 1991). Implementing sustainability (Dailey and Ehrlich 1992) requires first a fundamental shift in economic theory, application of less-damaging technology in agriculture to regulating international trade in essential resources. Second, sustainability requires interaction among social-political and economic environments, from individual life-styles to incorporating costs that appear distant (i.e., global warming and depletion of the ozone layer). Third, sustainability requires the conservation of diversity and recognition that local and regional habitat conversions affect global health.

On prairie conservation

Almost a half century has passed since Weaver (1954) noted that the disappearance of a major unit of vegetation—the North American Prairie—is an event worthy of consideration. Recognition of the significance of grasslands has been slow. Only recently do initiatives in Canada (WWFC 1988) and the United States (Johnson and Bouzaher in press) recognize intrinsic values of grasslands (specifically their relationships to global issues), the diversity on which agriculture depends, and the need to protect biological diversity important to all humankind.

The conservation of biological diversity is a task bigger than any national or agency jurisdiction (Knopf 1992). In the larger context of conserving biological diversity in agricultural and natural ecosystems in North America, prairies are a priority, perhaps the highest priority. It is time to bring a measure of prairie conservation to the forefront. In the short term, we suggest the following:

- Recognize the biological and ecological significance of prairie ecosystems. A reorientation of environmental concern and policy—beyond the emphasis on forested ecosystems—is a first step to create a more rational approach to conservation of biological diversity in North America.
- Identify and inventory remaining native prairie, particularly in but not limited to the western United States, and determine the degree to which existing prairie is degraded. Encourage protection of viable representatives of each native prairie type in each ecoregion.
- Identify, inventory, and conserve prairie endemics, particularly the unusually high number of plant and invertebrate species. Prairie management should mimic the natural disturbance regime to take advantage of preselected adaptive traits of prairie endemics.
- Evaluate the status of candidate threatened or endangered species, and encourage conservation measures to reverse downward trends in population numbers of prairie species.
- Discourage establishment of woody plants and woody corridors within prairie-dominated ecoregions. Such forested stepping stones and corridors contribute to a significant loss of genetic diversity in North America (Knopf 1986).
- Support public, private, and governmental prairie conservation initiatives, the Prairie Conservation Action Plan (WWFC 1988) and Great Plains Initiative (Johnson and Bouzaher in press) among others, as steps toward the long-term goal of sustainability.
- Realign administrative and ecoregion borders, as proposed for the US Department of Interior National Biological Survey, to achieve efficiency in inventory and planning, and in the case of the prairie, to

achieve a common vision for its conservation.

Acknowledgments

We wish to thank Larry D. Harris (School of Forest Resources and Conservation, University of Florida, Gainesville), Paul G. Risser (Miami University, Oxford, OH), Christopher D. Risbrudt (USDA Forest Service, Missoula, MT), Stanley E. Senner (National Audubon Society, Boulder, CO) and Terry L. West (USDA Forest Service, Washington, DC) for useful criticisms and helpful comments on the manuscript.

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